Final Report—Cree Lighting Confidential

Sphere Measurement

Test Number: [redacted]

Growth Number(s)/Substrate ID(s): [redacted]

Nominal Wavelength: 470 nm

Population Size: 1

Test Conditions: Large Sphere, 9V HS fan on

Package Features: Nine 2x2 Arrays on Submounts on ThermalTake HS; AgSn solder paste die onto submounts; Ag DA submounts to [redacted] Epoxy Domes loaded with1.5% Phosphor Concentration

Package ID: [redacted]

Description: Attempt to build a 1000 Lumen Lamp

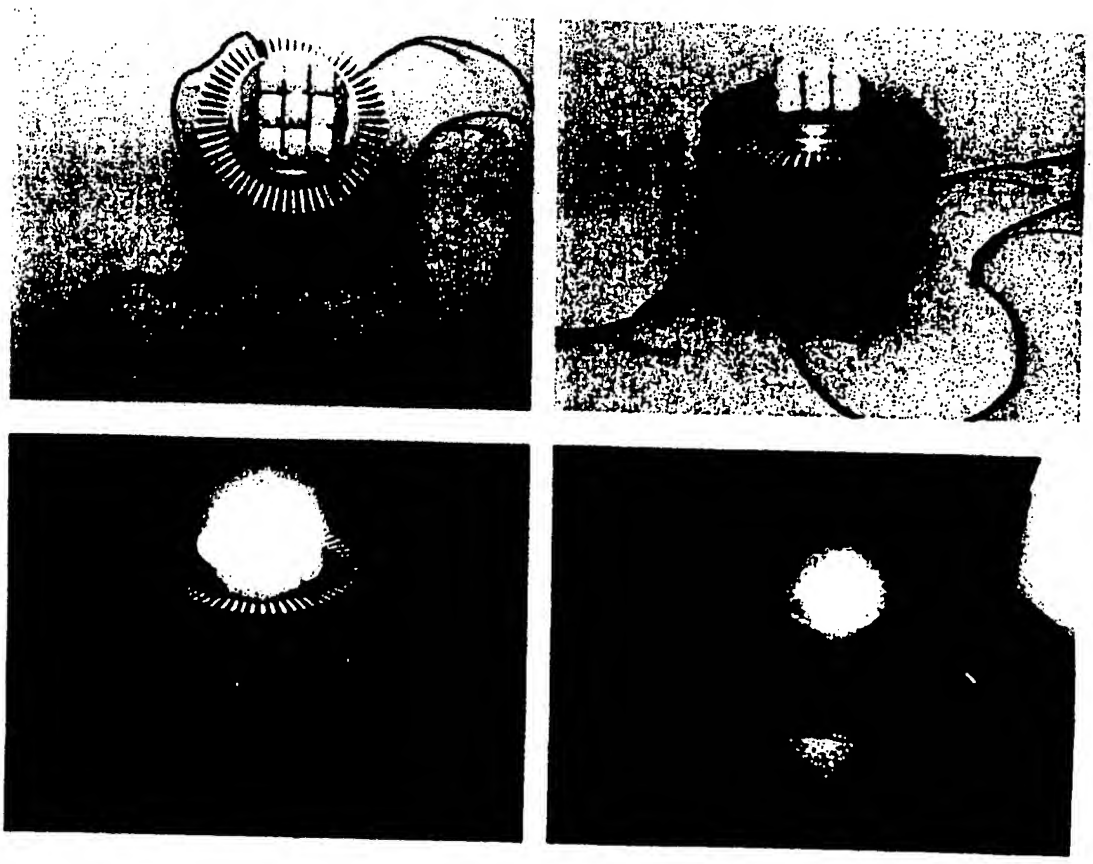


Figure 1: Pictures of the Lamp

Results:

Light Performance

The goal of 1000 lumen output was achieved at a current equivalent to 500 mA/die (total of 3 A). At 350 mA/die, the total lumen output of the lamp was 809 lumen, corresponding to a 22.5 lumen/die output. See figure 2 for Lumen vs. Current graphs.

Electrical Performance

For the sphere measurements, the device was powered by an external power supply. The V_f measurements came directly from the readout on the power supply. Both the voltage and the current that each device received were equivalent to one-sixth the total voltage and total current, respectively. See figure 2 for V_f vs. current graph.

Thermal Performance

The steady-state case temperature was measured on the package at each of the test currents. Ambient temperature of 22°C was measured when the device was off, and the temperature of the copper case plates reached a maximum of 72°C while running at 500 mA/die. The standard test current of 350 mA/die produced a temperature of 53°C. See figure 3 for the Steady State Case Temperature vs. Current graph.

Individual Lamp Data

The individual lamps were first measured before being mounted to the heat sink and ran together in test [redacted] The sum of the data was about 14% lower than the luminous output of the entire lamp when all nine devices were running at once. At 350 mA, the individual lamps luminous output totaled 695 lumens, as compared with 809 lumens for the entire lamp. This is [redacted] likely due to the much more significant rise in temperature the individual lamps underwent. They were measured simply on the submount test fixture for the sphere with no fan, while the entire package was on the ThermalTake heat sink with a thermal tape adhesive interface and a 9-V fan. See figure 3 for the Sum of Individual vs. All 9 Simultaneously graph.

Notes

The package consisted of nine 2x2 arrays, for a total of 36 die. The packages were arranged such that there were three submounts in series within three parallel paths. A power supply was obtained to run the lamps at 25.4 V and 2.90 A, which is the power necessary for an output of 1000 lumen. A 9-Volt battery

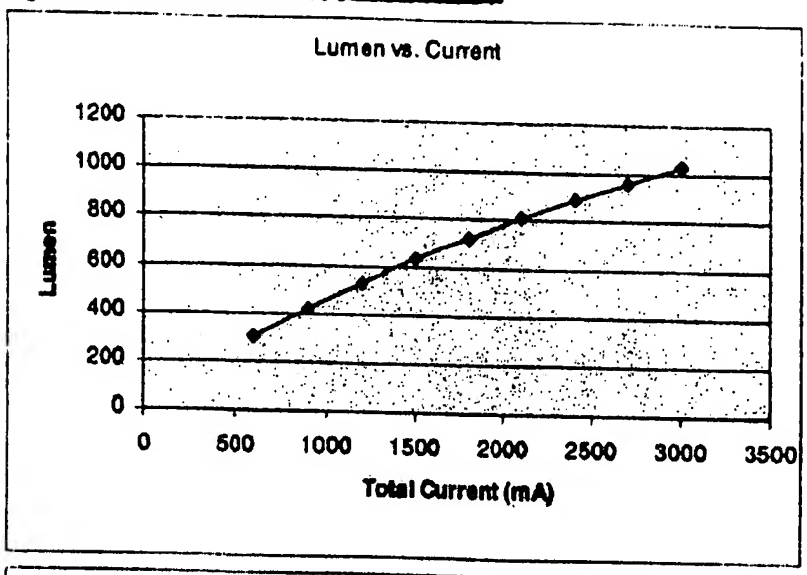
was used to power the fan on the heat sink. The thermal resistance of one device on the heat sink was measured to be 4.8 °C/W. Assuming minimal thermal cross-talk, this corresponds to the entire 1000 lumen package running with a thermal resistance of 0.5 °C/W.

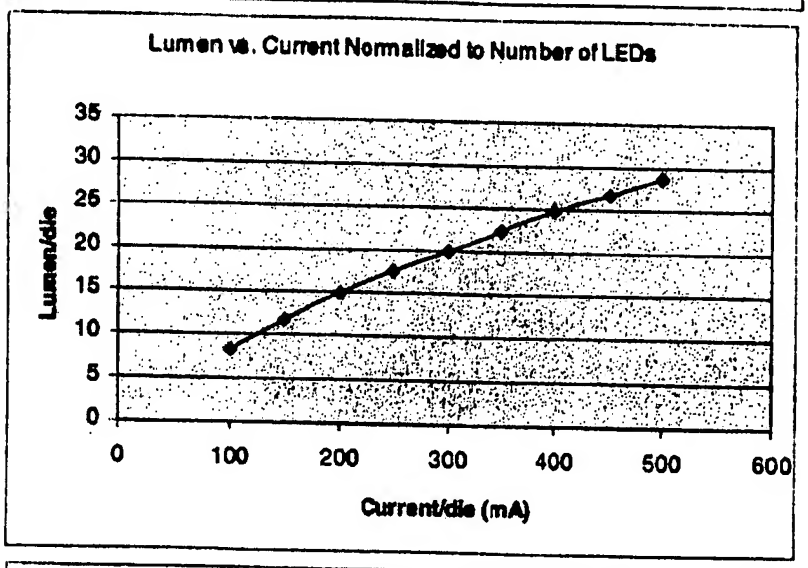
Summary & Conclusions

A 1000 lumen lamp has been designed using current package building procedures. A total of 36 die were used to obtain this goal, each outputting 28.7 lumen at 500 mA/die. The package began to heat up at the test current, so the HS fan was necessary to keep the devices within operating range. When running at 500 mA/die, the thermal tape adhesive used to connect the individual devices to the heat sink began to melt, so lower running power will be necessary to ensure proper contact of the devices to the heat sink.

Submitted: Mark Youmans
James Ibbetson

Figure 2. Charts from [redacted]





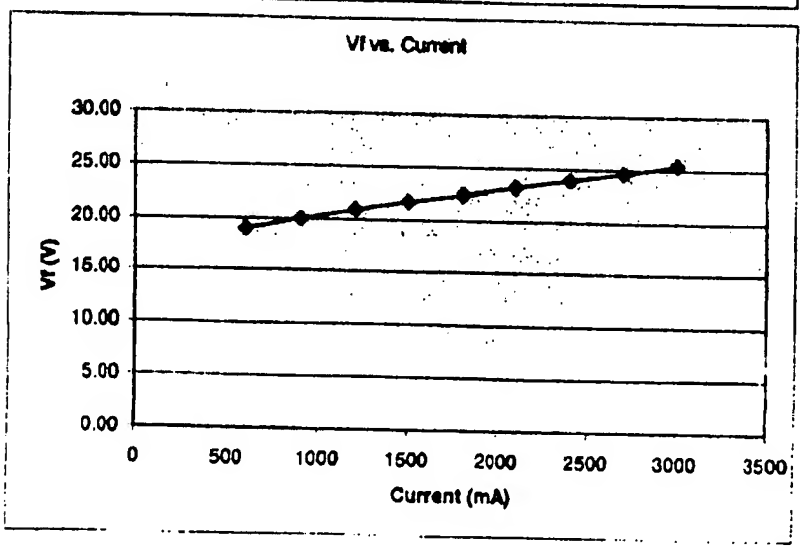
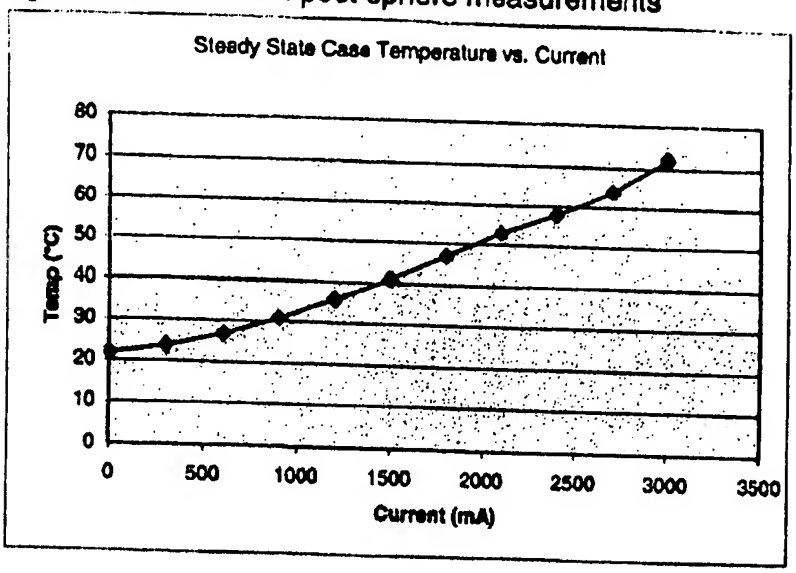
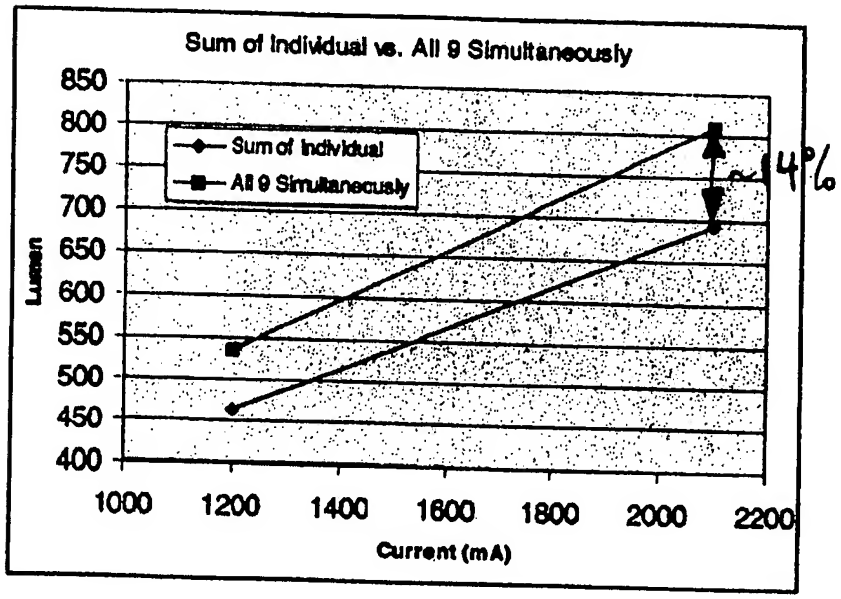


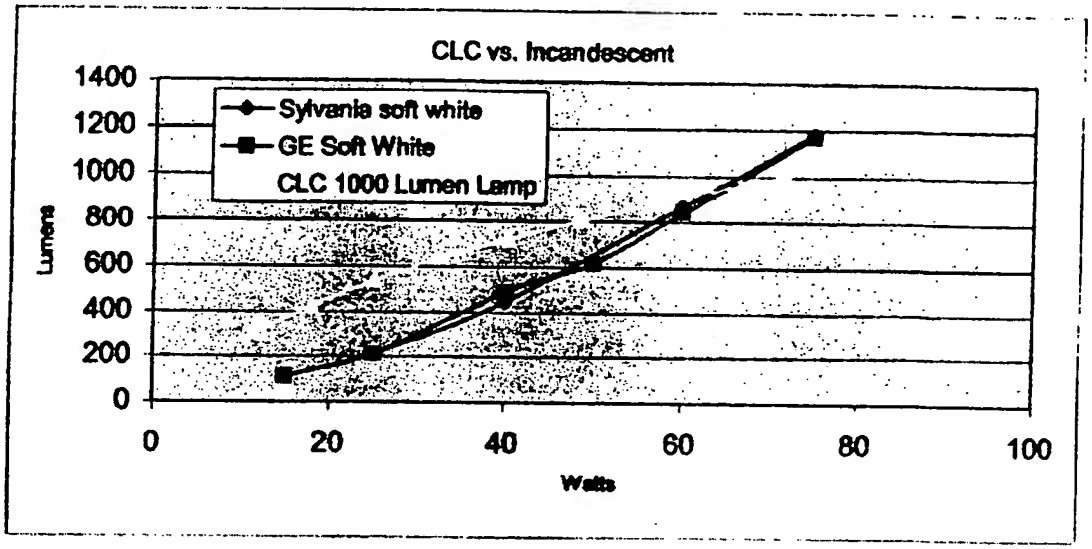
Figure 3. Charts from post-sphere measurements

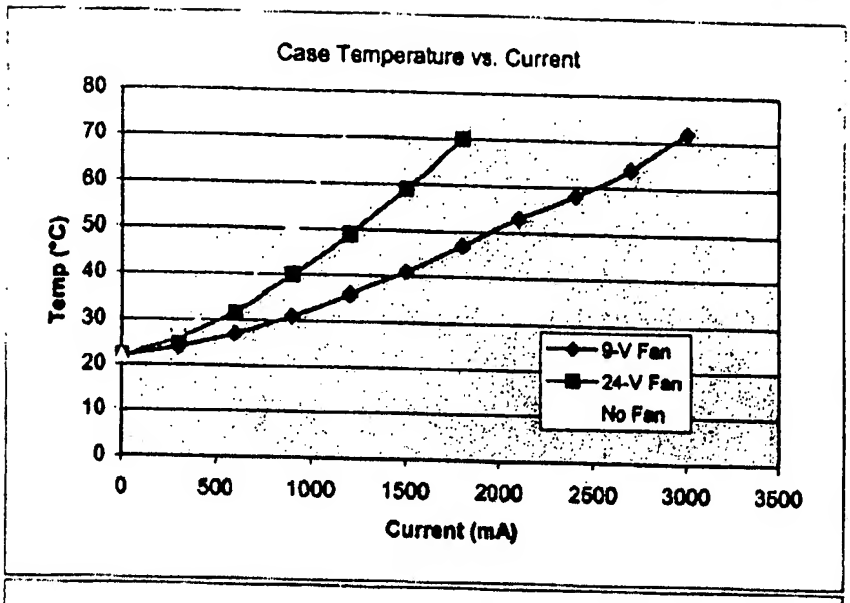


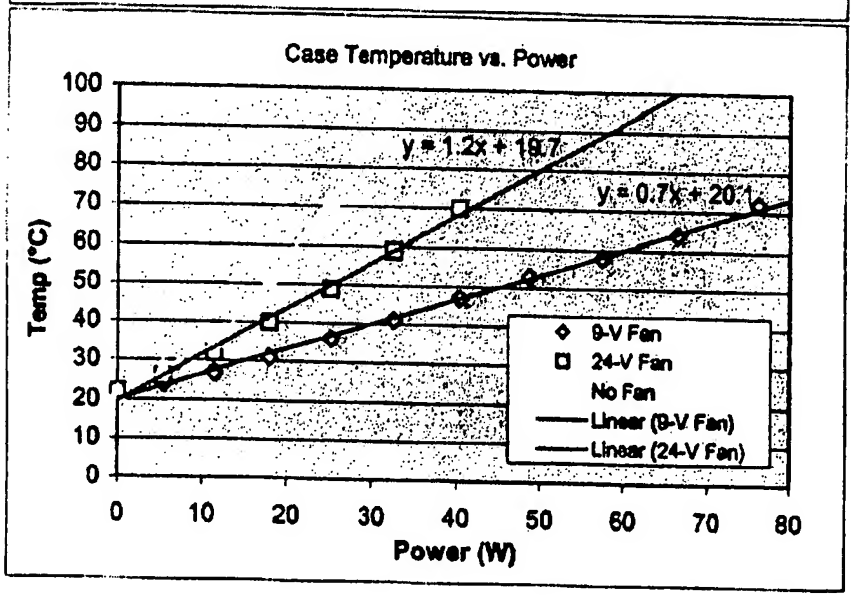


Type	Watt	Lumen
Sylvania soft white	15	109
	25	210
	40	445
	60	870
	75	1180
GE Soft White	15	110
	25	210
	40	490
	50	615
	60	840
	75	1170
CLC 1000 Lumen Lamp	11.4	301.30
	18.0	424.57
	25.1	536.31
	32.6	635.40
	40.3	721.38
	48.7	808.61
	57.4	889.44
	66.4	962.36
	76.2	1033.63

Sources:
http://members.aol.com/ajaynejr/lumen.htm#HouseIncand
http://www.gelighting.com/na/downloads/02_inc.pdf



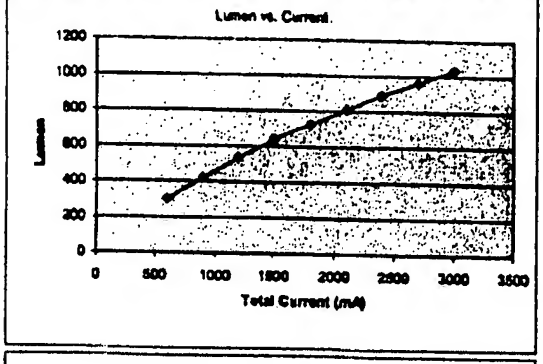

Case Temperature vs. Current
Temp (°C)
Current (mA)
9-V Fan
24-V Fan
No Fan


Case Temperature vs. Power
Temp (°C)
Power (W)
y = 1.2x + 19.7
y = 0.7x + 20.1
9-V Fan
24-V Fan
No Fan
Linear (9-V Fan)
Linear (24-V Fan)

[redacted] 9 2x2 Arrays on Submounts on ThermalTake HS

[redacted]

Device#	lp	ld	x	y	Lum	Flavia(uW)	Lum/W	CCT	Vf(V)	Lum/W	If(mA)	OE	W.P.(%)	Purity	CRI	FWHM	T °C
											0						22
1	452.0	466.0	0.312	0.329	301.30	961929	313.2	6450	19.00	26.43	600	58	6.44	7.52	76.1	22.0	24
2	450.0	459.0	0.310	0.326	424.97	1361928	311.7	6650	20.00	23.59	900	55	7.57	8.62	76.2	22.0	27
3	450.0	466.0	0.310	0.323	536.31	1726508	310.6	6650	20.90	21.36	1200	52	8.68	8.89	76.6	22.5	31
4	450.0	467.0	0.309	0.323	636.40	2054225	309.3	6650	21.70	19.52	1500	50	8.31	9.20	75.0	22.8	36
5	450.0	465.0	0.309	0.321	721.38	2343981	307.8	7000	22.40	17.86	1800	47	8.81	9.65	77.8	23.0	41
6	452.0	468.0	0.308	0.320	806.81	2630683	306.8	7000	23.20	16.60	2100	46	9.41	10.68	76.0	24.6	52
7	452.0	464.0	0.307	0.319	889.44	2904327	306.2	7000	23.90	15.51	2400	44	9.08	9.83	76.1	25.0	58
8	450.0	465.0	0.304	0.318	969.36	3150586	305.5	7000	24.60	14.48	2700	42	9.74	11.29	75.5	25.0	64
9	452.0	466.0	0.307	0.321	1033.69	3387784	305.1	7000	25.40	13.56	3000	41	9.48	10.12	77.4	25.5	72

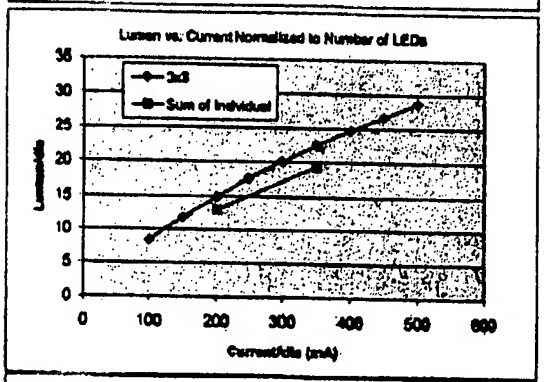


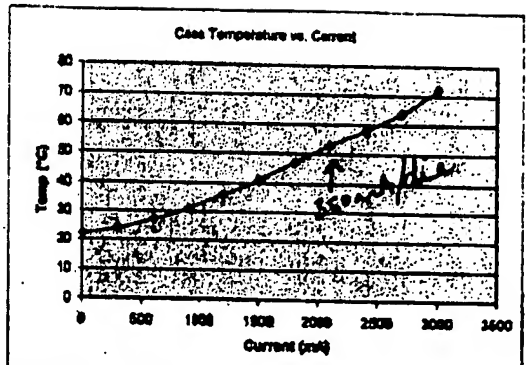
NOTE: Each chip receives 1/6 the total current

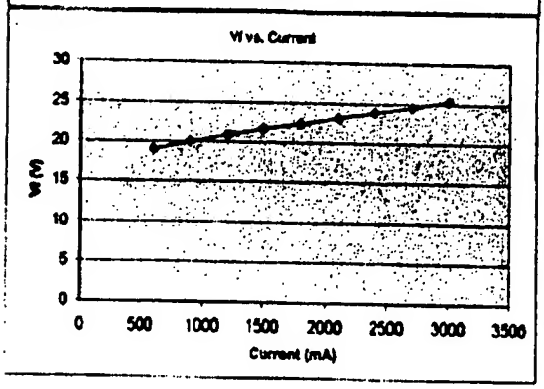
Per Die Characteristics

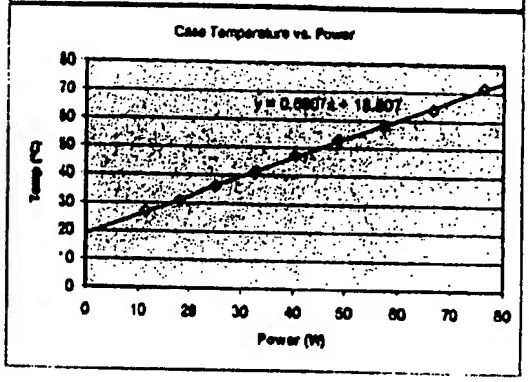
Average of Individual Die (from [redacted])

Power (W)	Ildie (mA)	Vf/die (V)	lum/die	lumens	Vf
11.4	100	3.17	8.37		
18.0	150	3.33	11.76		
25.1	200	3.48	14.99	13.0	3.56
32.8	250	3.65	17.65		
40.3	300	3.78	20.04		
48.7	350	3.87	22.46	19.3	4.02
57.4	400	3.99	24.71		
66.4	450	4.10	26.75		
76.2	500	4.23	28.71		





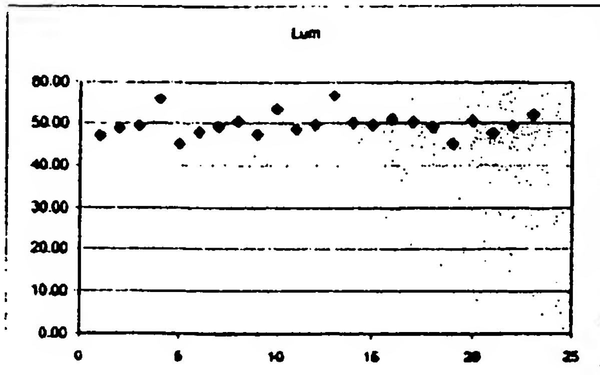


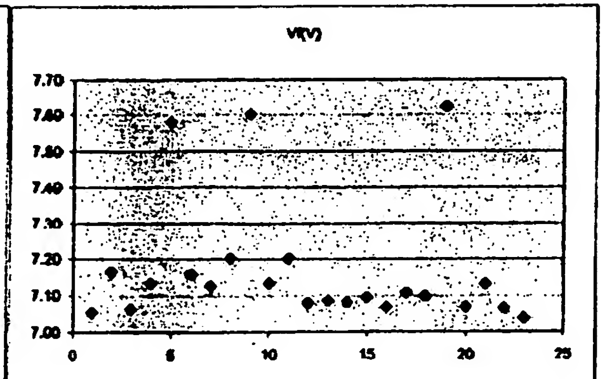


[redacted] 2x2 Array on Submount [redacted] Encapsulated

Device#	%	Ip	Id	x	y	Lum	Fbvis(uW)	Lum/kW	CCT	Vf(V)	Vr(V)	Lum/W	If(mA)	QE	W.P.(%)	Purity	CRI	Ir@-5V	Ir@-10V	FWHM	Rs
13	1.5	452.0	480.0	0.298	0.305	58.82	182389	295.4	7860	7.09	-20.83	20.04	400	17.53	6.79	14.4	78.5572	0.00	-0.28	22.0	2.97
4	1.5	452.0	480.0	0.298	0.305	55.86	187922	297.4	7860	7.13	-27.17	19.58	400	17.13	6.58	14.1	78.0289	0.00	-0.10	21.5	3.06
10	1.5	458.0	483.0	0.297	0.310	53.40	179844	297.3	7700	7.14	-31.97	18.71	400	16.52	6.29	14.2	80.737	0.00	-0.10	23.0	3.08
23	2.0	453.0	582.0	0.343	0.389	51.99	148845	349.3	5100	7.04	-15.98	18.47	400	13.59	5.29	20.0	75.5432	-0.01	-0.78	177.0	2.95
16	2.0	454.0	551.0	0.332	0.365	50.97	152082	335.1	5550	7.07	-31.75	18.02	400	13.92	5.38	8.9	78.6928	0.00	-0.09	158.5	3.01
20	2.0	456.0	563.0	0.345	0.388	50.60	146803	344.7	5100	7.07	-31.08	17.89	400	13.50	5.19	19.3	78.9789	0.00	-0.10	169.0	2.83
8	1.5	450.0	476.0	0.298	0.295	50.57	174308	290.1	8150	7.20	-31.28	17.55	400	15.81	6.05	16.2	76.2197	0.00	-0.09	21.0	3.10
17	2.0	458.0	563.0	0.348	0.400	50.41	142718	353.2	5100	7.11	-24.39	17.73	400	13.18	5.02	24.6	73.3237	0.00	-0.10	177.0	2.91
14	1.5	456.0	484.0	0.298	0.314	50.22	167942	299.0	7600	7.08	-30.58	17.72	400	15.44	5.93	13.4	81.257	0.00	-0.10	24.0	2.90
15	2.0	458.0	566.0	0.324	0.369	49.77	147660	337.1	5850	7.10	-31.28	17.63	400	13.67	6.20	11.1	79.7709	0.00	-0.00	162.0	3.08
12	1.5	452.0	479.0	0.293	0.297	49.75	171315	290.4	8400	7.08	-28.35	17.57	400	15.61	6.05	17.2	77.4493	0.00	-0.09	22.5	3.07
3	1.5	450.0	477.0	0.289	0.288	49.52	173452	285.5	9200	7.08	-30.47	17.53	400	15.74	6.14	18.4	78.9971	0.00	-0.11	22.5	2.98
22	2.0	450.0	555.0	0.334	0.367	49.44	146632	337.2	5560	7.07	-31.08	17.49	400	13.30	5.19	10.3	77.8071	0.00	-0.10	163.5	3.02
7	1.5	450.0	488.0	0.312	0.327	49.32	158256	311.6	6650	7.13	-31.61	17.30	400	14.36	5.55	7.7	77.2563	0.00	-0.09	22.0	3.05
18	2.0	458.0	560.0	0.341	0.382	49.27	143978	342.2	5100	7.10	-30.22	17.35	400	13.24	5.07	16.6	78.3432	0.00	-0.09	167.0	2.98
2	1.5	450.0	477.0	0.295	0.294	48.88	167537	291.7	8300	7.17	-29.63	17.05	400	15.20	5.85	16.7	[illegible]	0.00	-0.10	21.0	2.82
11	1.5	454.0	478.0	0.296	0.298	48.68	166322	292.7	8650	7.20	-30.54	16.89	400	15.22	5.77	16.0	78.57	0.00	-0.10	22.0	3.15
6	1.5	452.0	475.0	0.287	0.282	48.05	170795	281.3	10000	7.16	-29.61	16.78	400	15.58	5.96	20.9	76.9074	0.00	-0.10	21.0	3.00
21	2.0	452.0	553.0	0.332	0.364	47.76	143675	332.4	5550	7.13	-30.37	16.74	400	13.09	5.04	9.2	78.1267	0.00	-0.10	158.0	3.02
9	1.5	454.0	480.0	0.285	0.302	47.82	160817	296.5	[illegible]	[illegible]	[illegible]	[illegible]	400	[illegible]	[illegible]	[illegible]	[illegible]	0.00	-0.10	23.5	3.92
1	1.5	452.0	479.0	0.299	0.302	47.17	160284	294.3	7850	7.08	-31.58	16.71	400	14.60	5.68	14.7	78.061	0.00	-0.09	22.5	2.65
5	1.5	452.0	478.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-33.16	[illegible]	400	[illegible]	[illegible]	[illegible]	[illegible]	0.00	-0.10	22.5	3.50
19	2.0	452.0	587.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	400	[illegible]	[illegible]	[illegible]	[illegible]	0.00	-0.27	165.5	3.66

Ave of 1.5% Top 9	2	453.3	491.8	0.304	0.318	51.92	171705	303.7	7544	7.10	-28.30	18.27	400	15.69	6.04	15.6	77.7007	0.00	-0.12	41.8	3.00
Std Dev	0	3.0	29.0	0.018	0.036	3.03	16002	21.4	1223	0.03	3.92	1.04	0	1.43	0.56	4.9	2.48413	0.00	0.07	54.8	0.07

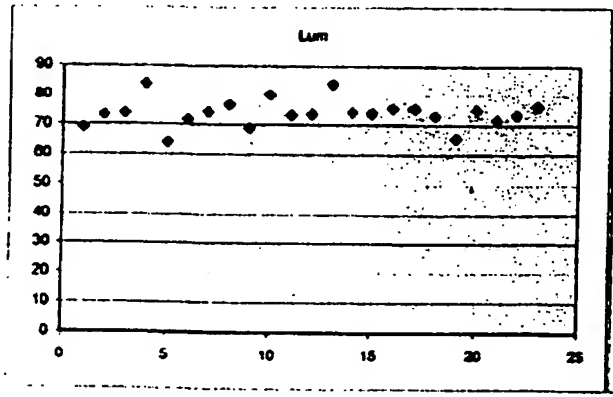




[redacted] 2x2 Array on Submounts [redacted] Encapsulated

Device#	RdFbx(uV	Ip	Id	x	y	Lum	Fbxvis(uV	Lum/W	CCT	Vf(V)	Vr(V)	Lum/W	If(mA)	QE	W.P.(%)	Purity	CRI	Ir@-5V	Ir@-10V	FWHM	Rs
13	1.5	452.0	479.0	0.295	0.299	84.06	297352	292.5	8050	8.00	-30.77	15.01	700	14.98	5.13	16.0	77.2058	0.00	-0.30	24.0	2.65
4	1.5	452.0	479.0	0.299	0.304	84.02	295232	294.6	7950	8.06	-28.82	14.89	700	14.85	5.06	14.1	78.6855	0.00	-0.10	23.0	2.70
10	1.5	456.0	482.0	0.296	0.306	80.42	272919	294.7	7980	8.07	-31.97	14.24	700	14.34	4.83	15.2	80.9674	0.00	-0.10	24.5	2.71
8	1.5	450.0	477.0	0.292	0.293	76.74	266731	287.7	8690	8.14	-31.15	13.46	700	13.63	4.68	17.5	76.1945	0.00	-0.10	22.0	2.74
23	2.0	454.0	561.0	0.343	0.384	76.33	220381	346.4	5100	7.85	-15.50	13.72	700	11.53	3.96	18.0	77.4494	-0.01	-0.73	184.0	2.64
16	2.0	454.0	547.0	0.329	0.361	75.60	227302	332.6	5560	7.99	-31.58	13.53	700	11.89	4.07	7.3	78.1345	0.00	-0.10	164.0	2.67
17	2.0	457.0	564.0	0.350	0.405	75.46	215106	350.8	5100	8.00	-24.52	13.47	700	11.33	3.84	26.9	74.6284	0.00	-0.11	183.0	2.60
20	2.0	456.0	559.0	0.338	0.380	75.18	219823	341.9	5100	7.96	-30.97	13.48	700	11.55	3.84	15.8	77.557	0.00	-0.11	174.0	2.63
14	1.5	458.0	483.0	0.297	0.310	74.36	251355	295.8	7800	7.96	-30.45	13.31	700	13.26	4.50	14.4	82.6873	0.00	-0.11	25.5	2.58
7	1.5	450.0	486.0	0.310	0.324	74.35	240942	308.6	8660	8.06	-31.64	13.18	700	12.49	4.27	8.8	78.4972	0.00	-0.10	23.5	2.71
15	2.0	454.0	552.0	0.332	0.366	73.91	221316	333.9	5550	8.03	-31.29	13.15	700	11.58	3.94	9.3	79.1384	0.00	-0.10	187.0	2.72
3	1.5	462.0	475.0	0.288	0.284	73.84	261446	282.4	9200	7.97	-30.37	13.24	700	13.81	4.89	20.2	77.4365	0.00	-0.17	24.0	2.64
12	1.5	452.0	478.0	0.290	0.294	73.66	268446	287.2	8800	8.01	-28.16	13.13	700	13.35	4.57	18.1	77.8002	0.00	-0.10	24.0	2.71
22	0.0	450.0	554.0	0.333	0.384	73.53	219882	334.4	5560	7.99	-31.03	13.15	700	11.40	3.93	9.2	78.5866	0.00	-0.10	187.5	2.69
11	1.5	452.0	477.0	0.296	0.297	73.27	252810	289.6	8150	8.16	-30.50	12.83	700	13.16	4.43	18.1	79.5198	0.00	-0.10	23.0	2.80
2	1.5	452.0	476.0	0.292	0.293	73.21	253759	288.5	8600	8.05	-29.34	12.99	700	13.21	4.50	17.9	78.7566	0.00	-0.11	23.5	2.57
18	2.0	456.0	558.0	0.337	0.381	73.05	215080	339.7	5175	8.01	-30.13	13.04	700	11.30	3.84	15.5	77.8539	0.00	-0.10	172.5	2.63
6	1.5	452.0	474.0	0.284	0.276	71.73	257410	276.7	10000	8.07	-29.74	12.69	700	13.40	4.55	22.4	76.5747	0.00	-0.10	22.5	2.85
21	2.0	452.0	539.0	0.327	0.367	71.66	217401	329.6	5850	8.05	-30.36	12.71	700	11.32	3.86	8.4	79.234	0.00	-0.11	161.5	2.68
1	1.5	452.0	478.0	0.295	0.299	69.04	237520	290.7	8150	7.91	-31.50	12.48	700	12.37	4.29	16.1	78.3436	0.00	-0.10	25.0	2.41
9	1.5	454.0	479.0	0.295	0.300	68.94	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
19	2.0	452.0	569.0	0.337	0.371	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
5	1.5	456.0	477.0	0.286	0.288	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]

Ave of 1.5% Top 9:	2	452.7	479.6	0.296	0.301	77.19	263915	292.6	8133	8.05	-29.09	13.70	700	13.76	4.68	15.6	78.5416	0.00	-0.13	23.7	2.70
Std Dev	0	2.6	3.5	0.008	0.012	4.47	15688	7.4	748	0.07	3.53	0.81	0	0.92	0.28	3.3	2.1396	0.00	0.07	1.0	0.06



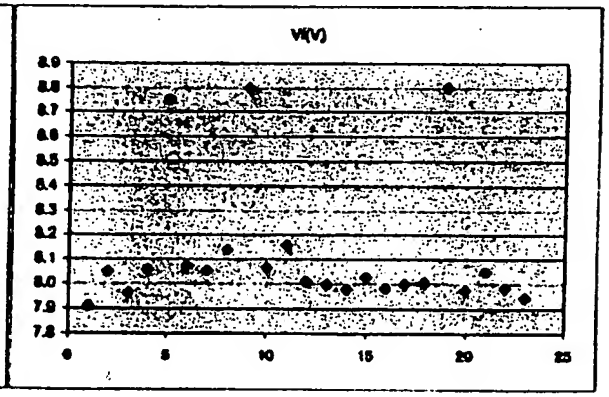


EXHIBIT B
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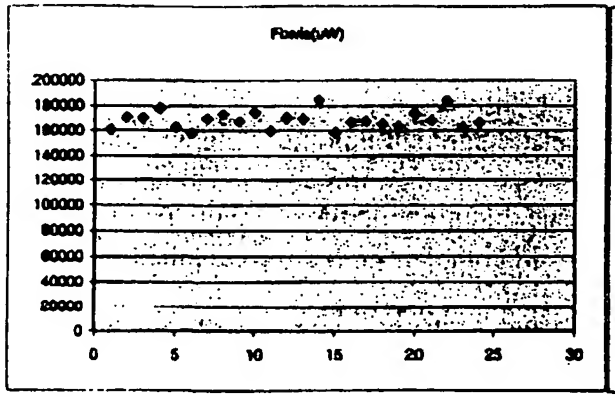
[redacted] 2x2 Array on Submount, [redacted] Unencapsulated

Device#	RdFlx(uW	lp	Id	x	y	Lum	Flxvlx(uW	Lum/f/W	CCT	Vf(V)	Vr(V)	Lm/W	If(mA)	QE	W.P.(%)	Purity	CRI	Ir@-5V	Ir@-10V	FWHM	Rs
1	0	454.0	459.0	0.149	0.034	7.58	160920	47.1	60000	6.98	-31.60	2.71	400	14.73	5.76	98.0	0	0.00	-0.09	21.0	2.40
2	0	452.0	459.0	0.147	0.029	7.53	171088	44.0	60000	7.14	-29.36	2.64	400	15.59	5.99	99.5	0	0.00	-0.09	19.5	2.91
3	0	453.0	457.0	0.152	0.033	7.79	170004	45.8	60000	7.05	-30.76	2.76	400	15.53	6.03	97.6	0	0.00	-0.10	20.5	2.94
4	0	454.0	459.0	0.149	0.034	8.32	179472	46.6	60000	7.06	-32.94	2.95	400	16.34	6.32	98.1	0	0.00	-0.09	20.5	3.02
5	0	454.0	461.0	0.142	0.032	7.70	162888	47.3	60000	7.01	-31.71	2.75	400	14.89	5.80	99.8	0	0.00	-0.09	20.0	2.26
6	0	452.0	458.0	0.149	0.031	8.97	157868	44.2	60000	7.13	-29.82	2.44	400	14.39	5.53	96.8	0	0.00	-0.10	19.0	2.96
7	0	453.0	457.0	0.153	0.033	7.72	169663	46.5	60000	7.09	-31.79	2.72	400	15.50	5.98	97.5	0	0.00	-0.09	20.0	2.97
8	0	452.0	457.0	0.150	0.030	7.65	173469	44.1	60000	7.16	-31.33	2.67	400	15.61	6.06	98.6	0	0.00	-0.09	19.0	3.07
9	0	456.0	460.0	0.148	0.037	8.18	167382	48.9	60000	7.06	-31.09	2.89	400	15.39	5.91	97.7	0	0.00	-0.09	20.5	3.01
10	0	466.0	461.0	0.147	0.039	8.86	174414	50.8	60000	7.11	-32.06	3.11	400	16.05	6.13	97.6	0	0.00	-0.09	19.5	3.10
11	0	454.0	459.0	0.148	0.034	7.49	159773	46.9	60000	7.16	-30.60	2.62	400	14.62	5.58	98.4	0	0.00	-0.09	20.0	3.10
12	0	453.0	459.0	0.150	0.032	7.70	170428	45.2	60000	7.07	-29.92	2.72	400	15.57	6.03	98.5	0	0.00	-0.25	20.0	2.99
13	0	464.0	459.0	0.149	0.033	7.85	169418	46.4	60000	7.11	-28.06	2.78	400	15.61	5.96	98.3	0	0.00	-0.09	20.0	3.05
14	0	457.0	462.0	0.146	0.040	9.51	184613	51.5	60000	7.08	-30.67	3.36	400	17.01	6.52	97.7	0	0.00	-0.09	20.0	2.91
15	0	455.0	461.0	0.145	0.034	7.70	159505	48.6	60000	7.08	-31.58	2.72	400	14.54	5.60	99.2	0	0.00	-0.09	20.5	3.06
16	0	456.0	462.0	0.140	0.031	7.97	167211	47.7	60000	7.04	-31.77	2.83	400	15.37	5.94	100.5	0	0.00	-0.10	20.5	3.03
17	0	458.0	462.0	0.146	0.040	8.82	167912	52.5	60000	7.09	-27.71	3.11	400	15.50	5.92	97.6	0	0.00	-0.09	20.0	2.88
18	0	456.0	462.0	0.141	0.035	8.27	165454	50.0	60000	7.10	-30.52	2.91	400	15.21	5.83	99.5	0	0.00	-0.09	20.5	2.99
19	0	452.0	458.0	0.149	0.031	7.32	168996	44.7	60000	7.15	-21.35	2.56	400	14.94	5.74	98.8	0	-0.01	-0.39	19.5	3.01
20	0	456.0	461.0	0.147	0.037	8.65	173464	48.9	60000	7.06	-31.43	3.07	400	16.05	6.15	97.9	0	0.00	-0.09	20.5	2.91
21	0	454.0	459.0	0.147	0.031	7.60	168256	45.2	60000	7.13	-30.64	2.67	400	15.40	5.90	99.2	0	0.00	-0.09	19.5	3.02
22	0	452.0	458.0	0.151	0.033	8.37	184275	45.4	60000	7.05	-31.23	2.97	400	16.79	6.53	98.0	0	0.00	-0.10	19.5	3.02
23	0	456.0	461.0	0.144	0.034	7.92	162963	48.6	60000	7.01	-16.46	2.82	400	14.98	5.82	99.2	0	-0.01	-0.68	21.0	2.96
24	0	456.0	462.0	0.143	0.037	8.37	166702	50.2	60000	7.13	-26.30	2.93	400	15.33	5.84	98.8	0	0.00	-0.16	20.0	2.98



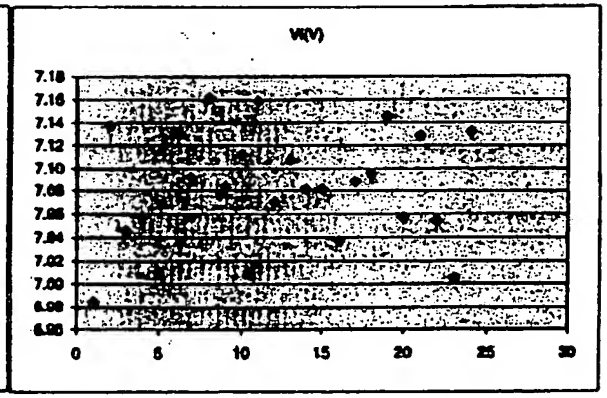


EXHIBIT B
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[redacted] 2x2 Array on Submount [redacted] Unencapsulated

Device#	RdFlx(uW	Ip	Id	x	y	Lum	Flxvis(uW	Lum/W	CCT	Vf(V)	Vr(V)	Lum/W	If(mA)	QE	W.P.(%)	Purity	CRI	Ir@-5V	Ir@-10V	FWHM	Rs
1	0	456.0	460.0	0.149	0.037	11.10	225767	48.9	60000	7.82	-31.42	2.03	700	11.91	4.14	97.5	0	0.00	-0.10	23.0	2.38
2	0	452.0	458.0	0.148	0.030	11.79	264264	44.6	60000	8.02	-29.35	2.10	700	13.76	4.71	98.9	0	0.00	-0.11	20.5	2.61
3	0	452.0	460.0	0.145	0.031	11.41	247230	46.2	60000	7.94	-26.38	2.05	700	12.87	4.45	99.5	0	0.00	-0.11	21.5	2.57
4	0	455.0	460.0	0.146	0.034	12.12	257822	47.1	60000	7.96	-82.12	2.16	700	13.49	4.62	98.4	0	0.00	-0.10	21.5	2.73
5	0	456.0	462.0	0.144	0.036	11.20	225428	49.7	60000	7.86	-31.68	2.04	700	11.84	4.10	98.8	0	0.00	-0.10	22.5	2.29
6	0	452.0	456.0	0.154	0.032	11.69	262962	44.5	60000	8.04	-29.89	2.08	700	13.69	4.67	97.4	0	0.00	-0.10	20.5	2.63
7	0	452.0	458.0	0.150	0.032	10.84	239869	45.4	60000	8.01	-31.60	1.93	700	12.44	4.26	99.3	0	0.00	-0.10	21.0	2.68
8	0	453.0	458.0	0.149	0.031	11.16	251019	44.5	60000	8.10	-31.27	1.97	700	13.10	4.43	98.7	0	0.00	-0.10	20.5	2.74
9	0	456.0	462.0	0.143	0.035	12.19	247621	49.2	60000	8.00	-30.54	2.16	700	13.01	4.42	99.2	0	0.00	-0.11	21.5	2.72
10	0	456.0	460.0	0.149	0.039	13.51	288432	50.3	60000	8.05	-31.97	2.40	700	14.10	4.76	97.1	0	0.00	-0.10	20.5	2.75
11	0	453.0	458.0	0.151	0.035	11.66	246836	47.2	60000	8.11	-30.42	2.05	700	12.86	4.35	97.4	0	0.00	-0.10	21.0	2.78
12	0	453.0	460.0	0.146	0.030	12.43	273753	45.4	60000	8.00	-21.07	2.22	700	14.29	4.89	99.5	0	0.00	-0.26	21.5	2.69
13	0	454.0	460.0	0.147	0.032	11.85	251491	48.3	60000	8.04	-26.32	2.07	700	13.15	4.47	98.8	0	0.00	-0.10	20.5	2.72
14	0	458.0	463.0	0.141	0.036	14.83	281973	51.9	60000	7.98	-30.59	2.62	700	14.81	5.05	99.1	0	0.00	-0.10	21.0	2.62
15	0	455.0	460.0	0.145	0.034	11.80	243756	48.4	60000	8.01	-31.34	2.10	700	12.78	4.35	98.8	0	0.00	-0.10	21.0	2.70
16	0	456.0	461.0	0.140	0.032	11.94	248843	48.0	60000	7.96	-31.63	2.14	700	13.07	4.47	100.3	0	0.00	-0.10	21.0	2.71
17	0	460.0	463.0	0.142	0.041	13.20	246801	53.5	60000	7.98	-35.31	2.36	700	13.08	4.42	98.2	0	0.00	-0.10	21.5	2.59
18	0	456.0	461.0	0.143	0.036	12.52	246976	50.1	60000	8.01	-30.44	2.23	700	13.13	4.46	98.9	0	0.00	-0.10	21.0	2.67
19	0	452.0	457.0	0.151	0.032	12.25	274896	44.6	60000	8.06	-20.24	2.17	700	14.32	4.87	98.1	0	-0.01	-0.46	19.5	2.68
20	0	458.0	460.0	0.147	0.038	13.08	259182	50.4	60000	7.96	-31.18	2.35	700	13.82	4.65	97.7	0	0.00	-0.10	21.0	2.64
21	0	454.0	460.0	0.146	0.030	12.10	288094	45.1	60000	8.05	-30.41	2.15	700	14.62	4.76	99.6	0	0.00	-0.10	20.5	2.70
22	0	452.0	457.0	0.151	0.033	12.37	270833	45.7	60000	7.97	-30.95	2.22	700	14.09	4.85	97.8	0	0.00	-0.10	21.0	2.72
23	0	456.0	460.0	0.146	0.036	12.13	246839	49.2	60000	7.91	-16.26	2.19	700	12.95	4.45	99.5	0	-0.01	-0.66	22.0	2.66
24	0	456.0	461.0	0.146	0.037	12.53	247515	50.6	60000	8.04	-23.29	2.23	700	13.08	4.49	98.4	0	0.00	-0.17	21.0	2.67